

ATTENUATION OF HIGH-FREQUENCY GROUND WAVES OVER AN INHOMOGENEOUS EARTH

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The primary objective of this study was to obtain theoretical estimates of the effect of inhomogeneities in the earth's surface upon ground-wave propagation along a particular set of land-sea paths.

The results were obtained by numerically solving the integral equation

$$f^*(d) = f(d) + \int g(d, \theta) f(-d \cos \theta) f^*(d \cos \theta) d\theta,$$

where f^* is the attenuation function for the inhomogeneous case, f is the Sommerfeld function, and g is obtained essentially from the spherical Green's function by a steepest-descent type integration.

Sharp phase and amplitude changes in the attenuation function occur when crossing an "island" or inhomogeneity in the paths. The greater the difference in conductivity and dielectric constant between the island and the rest of the path, the greater are these changes. Also noted is the "recovery" or "focusing" effect found in the amplitude and phase. The effect of moving the transmitting antenna across a coastline was also studied and the results were quite similar to the above.

Computations were performed for three paths at frequencies of 10, 15, 20, and 25 MHz. The results are displayed in tabular and graphical form.

This report is a revised and updated version of an earlier study (Rosich, 1968) which is now out of print.

Key Words: Electromagnetic waves; ground wave; integral equations; propagation; radio waves; Sommerfeld solution; surface waves

I. INTRODUCTION

This report describes the model used and the results obtained in a study (Rosich, 1968) of the effect that inhomogeneities in the earth's surface have upon the attenuation of the surface-wave component of the ground-wave electric field at high frequencies. Results are also presented from a more recent study (Rosich, 1969) of the effect on the attenuation of the placement of antennas near a coastline. All of these results were obtained from a model (Hufford, 1952; Wait, 1956; King, 1965) where the attenuation function is given by an integral equation that is solved numerically. The computations presented here were made for a particular set of land-sea paths (fig. 1) to aid in the design and evaluation of high-frequency ground-wave paths from the Naval Research Laboratory's Chesapeake Bay installation. Since the time of publication of the original report (Rosich, 1968), however, a number of things have come to pass: (1) the report has come into great demand, presumably because it indicates the type of behavior to be expected at high frequencies, (2) the report has gone out of print, and (3) better models (see for example, Ott and Berry, 1970) have been developed than that used in the report. In order to solve the problem caused by (1) and (2) and to direct further attention to the significant advances embodied in (3), this report is being issued. With particular regard to (3), we shall display some comparisons of the model presented here with that developed by Ott and Berry (1970) and Ott (1971a, b). These comparisons will also help to point out the accuracy and limitations of the model presented in this report.

Since this is an updating and improvement of the original report (Rosich, 1968), and since it contains all of the material there and more, it is intended to supplant the earlier report.

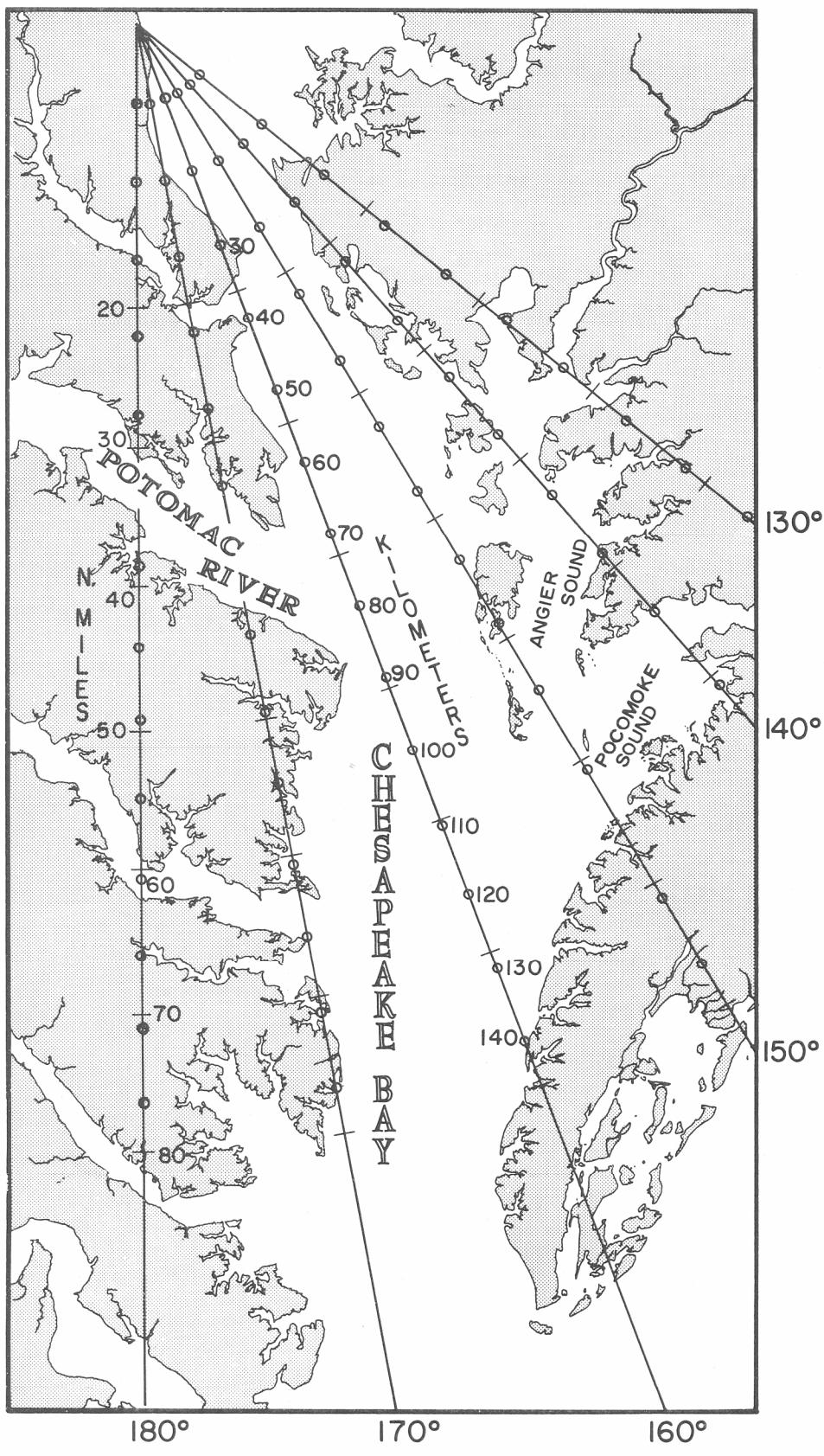


Figure 1. Map of the propagation paths on the Chesapeake Bay.